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विद्युत रासायनिक विश्लेषक की कार्यकारिता अभिव्यक्ति

भाग 3 विद्युत अपघटनी चालकता

Indian Standard

EXPRESSION OF PERFORMANCE OF ELECTROCHEMICAL ANALYZERS

PART 3 ELECTROLYTIC CONDUCTIVITY

UDC 621·35·035 : 543·133·08

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Price Group 8

Electronic Measuring Equipment Sectional Committee, LTD 21

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Electronic Measuring Equipment Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

This standard is intended to specify the terminology, definitions, requirements for statements by manufacturers and performance tests for analyzers, sensor units and electronic units used for the determination of electrolytic conductivity of aqueous solutions.

While preparing this standard (Part 3), assistance has been derived from IEC Pub 746-3 (1985) 'Expression of performance of electrochemical analyzers — Part 3 : Electrolytic conductivity', issued by the International Electrotechnical Commission (IEC).

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 ' Rules for rounding off numerical values (*revised*)'.

Indian Standard

EXPRESSION OF PERFORMANCE OF ELECTROCHEMICAL ANALYZERS

PART 3 ELECTROLYTIC CONDUCTIVITY

1 SCOPE

1.1 This standard lays down performance tests and requirements for statements by manufacturers of analyzers, sensor units and electronic units used for the determination of electrolytic conductivity of aqueous solutions.

2 REFERENCES

2.1 The Indian Standard listed below is a necessary adjunct to this standard :

IS No.	*Title*
13673 (Part 1) : 1993	Expression of performance of electrochemical analyzers : Part 1 General

3 DEFINITIONS

3.0 *See* 3 of IS 13673 (Part 1) : 1992 plus the following.

3.1 Electrolytic Conductance

The current divided by the potential difference is defined as electrolytic conductance in the case of ionic charge transport.

$$G = \frac{I}{U} \qquad ...(1)$$

where

I is the current through electrolyte, in amperes;

U is the potential difference applied across the electrodes in volts; and

G is the electrolytic conductance.

The unit of electrolytic conductance is the Siemens (S). Electrolytic resistance is the reciprocal of electrolytic conductance with ohm (Ω) as the unit of measurement.

3.2 Electrolytic Conductivity

Electrolytic conductivity, formerly called specific conductance, is defined by the equation:

$$X = \frac{j}{E} \qquad ...(2)$$

where

j is the electric current density, in $A.m^{-2}$; and

E is the electric field strength, in $V.m^{-1}$.

The unit of electrolytic conductivity is $S.m^{-1}$. Electrolytic resistivity is the reciprocal of electrolytic conductivity with units of ohm meter (Ω_m). In the case of an electrolytic conductor of a uniform cross-section A and l and an electrolytic conductance G (*see* **3.1**). We have

$$X = \frac{Gl}{A} \qquad ...(3)$$

It is usual to measure electrolytic conductivity by means of cells without a uniform cross-section, in which case the quotient $1/A$ should be determined by means of a reference solution of known electrolytic conductivity. The quotient $1/A$ is called the cell constant.

At the electrode surfaces polarization phenomena can occur which influence the measured quantity. To avoid this error, different measuring methods can be applied:

1) AC measurements with a frequency high enough to avoid polarization effects,
2) Four electrode measurements with separated current transporting and potential measuring electrodes, and
3) Inductive or capacitive measurements by coupling between the electrolytic conductor and the electrical measuring circuit through non-conductive media.

In each case the relationship between the electrolytic conductivity and the measured output quantity is established by the cell constant.

3.3 Cell Constant of the Sensor Unit

The relationship between electrolytic conductance and electrolytic conductivity is defined by the equation:

$$x = K_{cell} \cdot G \qquad ...(4)$$

where

x is the electrolytic conductivity, in $S.m^{-1}$;

G is the electrolytic conductance, in Siemens; and

K_{cell} is the cell constant, in m^{-1} in place of cell conductance.

NOTE — The cell constant will normally have a constant value over a stated range (*see* **4.1**). Outside this range it should be expected that polarization effects will produce errors.

3.4 Temperature Coefficient

The relative increase (or decrease) of the electrolytic conductivity of a solution per degree kelvin temperature change. The temperature coefficient is strongly dependent on the application.

The following equation can be applied:

$$x_{t_r} = \frac{x_t}{(1 + a\,\Delta t)} \qquad ...(5)$$

where

x_t is the electrolytic conductivity at temperature t,

x_{t_r} is the electrolytic conductivity at a reference temperature t_r,

Δt is the temperature difference $t-t_r$, and

a is the temperature coefficient.

The unit of temperature coefficient is K^{-1}.

In practice, this formula is sufficiently accurate over a small temperature range. For large temperature ranges it is usually necessary to add higher terms of a polynominal series such as $\beta(\Delta t)^2 + \gamma(\Delta t)^3 + \ldots\ldots$ to equation (5), to obtain sufficient accuracy. The percentage temperature coefficient, which is the percentage relative deviation per degree kelvin from the reference value x_{t_r} is often used so that:

$$a(\%) = 100\,a \qquad \ldots(6)$$

3.5 Common Mode Input Voltage

A voltage that is applied to both input terminals at the same time.

3.6 Input Common Mode Rejection Ratio (CMRR)

The ratio of the input voltage range to the maximum change in input offset voltage over this range.

4 PROCEDURE FOR STATEMENT

4.0 *See* **4** of IS 13673 (Part 1) : 1993 plus the following:

NOTE – Warm-up time statement is not required for sensor units. For complete analyzers, statement on warm-up time refers only to electronic units and is validated as in IS 13673 (Part 1) : 1993.

4.1 Statements on Sensor Units

a) Cell Constant.
b) Temperature Compensation Range, if applicable.
c) Type of temperature compensation system, if any, with electrical characteristics and limiting values.
d) Whether Flow-Through Type, Immersion Type or other.
e) Flow Range, in the case of a Flow-Through Type Sensor Unit.
f) Materials in Contact with the Sample and Coating of the Electrodes Cell.
g) Pressure Working Range.
h) Temperature Working Range.
j) Sensor Dimensions.

4.2 Additional Statements on Electronic Units

a) Measuring Frequency.
b) Temperature Compensation Range, if applicable.
c) Type of temperature compensation element of the sensor unit to which the electronic unit can be adapted.
d) Possibility of Adjustment for Reference Temperature of the Sample.
e) Maximum Allowable Common Mode Input Voltage.
f) Input Common Mode Rejection Ratio (CMRR).

NOTE — It applies only in the case of certain four electrode conductivity measuring systems.

g) Maximum Voltage Across the Sensor.

4.3 Additional Statements on Complete Analyzers

a) Conductivity Measuring Ranges (Rated and Effective).
b) Reference Temperature for the Sample.
c) Temperature coefficient or temperature coefficient range used in the temperature compensation.
d) Adjustment Range for Cell Constant.
e) Electrolytic conductivity and/or composition of solution used for temperature compensation.

5 RECOMMENDED STANDARD VALUES AND RANGES OF INFLUENCE QUANTITIES AFFECTING THE PERFORMANCE OF ELECTRONIC UNITS

See **5** of IS 13673 (Part 1) : 1993.

6 VERIFICATION OF VALUES

See **6** of IS 13673 (Part 1) : 1993 plus the following.

6.1 General

During measurements with more than one test solution, the sensor unit treatment described in **6.1.1** is to be used for:

- linearity error, if applicable;
- repeatability error;
- stability error; and
- temperature effect on the sensor unit.

When using a sensor unit of one manufacturer and an electronic unit of another manufacturer, the specific test methods for the electronic unit shall be agreed upon between the user and the manufacturer of the electronic unit.

6.1.1 In the above-mentioned cases, the sensor unit shall be rinsed several times with water having a conductivity negligible within the rated operating range, then rinsed with new solution and only then shall it be immersed in a beaker filled with fresh solution. This procedure shall be repeated each time, in the event that several series of measurements are prescribed.

In the case of flow-through systems, the verification of values shall be carried out under flow conditions as specified by the manufacturer.

6.2 Calibration Solutions and Test Solutions

For calibration solutions, *see* Annex A.

For test solutions, *see* Annex B.

6.3 Test Procedures

In the case of special appliactions where these tests are not appropriate, test procedures shall be agreed upon between manufacturer and user.

6.3.1 *Operating Error*

See **6.7.1** of IS 13673 (Part 1) : 1993

6.3.2 *Linearity Error (If Linearity is Claimed)*

6.3.2.1 *Sensor unit*

Using an appropriate electronic unit, perform the test as indicated in **6.3.2.2.**

6.3.2.2 *Analyzer*

The sensor unit is exposed to at least five calibration solutions representing approximately uniformly distributed conductivites, including approximately the minimum and maximum rated values for the analyzer. The first order least square fit is calculated and the maximum deviation from the regression line is determined. This maximum deviation from the regression line is determined. This maximum deviation is the linearity error and is expressed in terms of percentage of the rated range.

NOTE – For reasons of efficiency, this test may be combined with the test for repeatability error (*see* **6.3.3.2**).

6.3.3 *Repeatability Error*

6.3.3.1 *Sensor unit*

Using an appropriate electronic unit perform the test as indicated in **6.3.3.2**.

6.3.3.2 *Analyzer*

The senser unit is exposed sequentially to test solutions representing as nearly as possible the minimum, the maximum and the medium rated conductivities.

The steps are repeated six times on each test solution in turn, at reference temperature, with no rinsing between the six readings, at intervals of about ten times the instrument's 90 percent time. The standard deviation is calculated for each set of six recorded values for each solution. The average of the three standard deviations is calculated and reported as repeatability error. The temperature of all solutions and the sensor unit should be the same within ±0.2°C and reported along with the repeatability error.

6.3.4 *Stability Error*

6.3.4.1 *Sensor unit*

Using an appropriate electronic unit, perform the test as indicated in **6.3.4.2.**

6.3.4.2 *Analyzer*

The sensor unit is exposed to test solutions representing as nearly as possible the mid-scale rated conductivity value and the indicated value is recorded. This is repeated after the specified time interval and the stability error is calculated and reported as a percentage value in terms of the rated range. The temperature of all solutions and the sensor unit shall be the same within ±0.2°C and reported along with the stability error.

6.3.5 *Output Fluctuation for the Analyzer*

For this test the analyzer output shall be displayed on a recorder with a 90 percent time less than the 90 percent time of the anlyzer.

The sensor unit is exposed to a stable test solution representing approximately the midscale conductivity value, at any constant temperature within the rated range of sample temperature, for a period of 5 min and the maximum peak to peak value for the random, or regular deviations from the mean output is determined as a percentage value in terms of the rated range. The test is repeated three times and the average of the readings is reported.

6.3.6 *Delay Time* (T_{10}), *Rise* (*Fall*) *Time* (T_r,T_f), *90 Percent Time* (T_{90})

These properties are usually a function of the particular application rather than the instrument. Therefore, it is advisable to design the test in line with the application in so far as possible. Two procedures are described in Annex C. Procedure A is preferred and obligatory if flow cells are involved.

6.3.7 *Input Common Mode Rejection Ratio**

Apply the stated maximum common mode input voltage, with respect to earth, to both input terminals of the electronic unit and report the instrument's output value. Then apply an input voltage to the instrument giving the same output reading. Calculate the CMRR as follows:

$$\text{CMRR} = -20 \log \frac{V_c}{V_i} \qquad \text{... (7)}$$

where

V_i is the input signal, in volts;

V_c is the maximum common mode input voltage; and

CMRR is the common mode rejection ratio, in decibels.

6.3.8 *Operating Period*

The purpose of this procedure is to test the analyzer under worst case conditions.

The operating period depends generally on the working conditions. Therefore, the test should be agreed upon between the manufacturer and the user.

6.3.9 *Cell Constant*

6.3.9.1 *Sensor unit*

Using an appropriate electronic unit, perform the test as described below :

The sensor unit is immersed in a calibration solution at reference temperature and the measured conductance is reported. The cell constant is calculated as follows:

$$K_{\text{cell}} = \frac{X_{t_r}}{G} \qquad \text{... (8)}$$

where

K_{cell} is the cell constant, in m^{-1};

X_{t_r} is the electrolytic conductivity of calibration solution, at reference temperature, in S.m^{-1}; and

G is the measured electrolytic conductance in Siemens

NOTES

1 In practice, this test is very often performed by comparing the calculated cell constant with the cell constant of a calibrated cell.

2 This test shall be performed at the same measuring frequency and waveform as are used with the analyzer.

6.3.9.2 *Analyzer*

If the analyzer has a fixed setting for the cell constant, the instrument reading gives directly the electrolytic conductivity. In the case of a variable setting for the cell constant, this is set in such a position that the reading matches the stated conductivity of a calibration solution of a mid-range conductivity. After that, two measurements are made with calibration solutions representing approximately the lower and upper limits of the rated range of use.

---

*This test applies only in the case of certain four-electrode conductivity measuring systems.

6.3.10 *Effect of Sample Temperature*

This test is only applicable to conductivity analyzers having temperature coefficient compensation.

6.3.10.1 *Sensor units*

Using an appropriate electronic unit, with compatible measuring frequency, perform test as indicated in **6.3.10.2.**

6.3.10.2 *Analyzer*

The sensor unit is immersed successively in two containers filled with a calibration solution with a known temperature coefficient (*see* **4.1.8**).

The temperature of the solution in the first container shall be near to the minimum value of the rated operating range for the sensor unit and the temperature of the solution in the second container shall be near to the maximum value of the rated operating range for the sensor unit. Adequate stirring of the solution, with a non-magnetic device, and adequate immersion depth and well clearance for the sensor unit shall be ensured in each case.

The two steady-state indicated values are reported, alongwith the respective temperatures.

The values obtained are used to calculate a temperature coefficient, after which this value is reported, together with the stated value of the calibration solution and the measuring temperatures. The temperature coefficient is calculated as follows:

$$a_t = \frac{[K_{cell}\,(G_2 - G_1)]}{[x_{t_r}\,(t_2 - T_1)]} \qquad \text{.... (9)}$$

where

K_{cell} is the cell constant of the sensor unit,

G_1, G_2 is the measured electrolytic conductances at temperatures t_1 and t_2 respectively, and

x_{t_r} is the electrolytic conductivity of calibration solution at reference temperature.

If the electrolytic conductivity analyzer has a fixed temperature coefficient compensation, the calculation is made as described above, and the resulting value is divided by the stated temperature coefficient of the calibration solution and multiplied by 100, after which this value is reported as percentage temperature coefficient error.

If the conductivity analyzer has a variable temperature coefficient setting, the stated temperature compensation value of the calibration solution is set on the analyzer, prior to the testing procedure above. The same calculations are made as with the fixed temperature coefficient compensation.

ANNEX A

(*Clause* 6.2)

ELECTROLYTIC CONDUCTIVITY VALUES OF POTASSIUM CHLORIDE CALIBRATION SOLUTIONS*

Calibration Solution	*Approximate Concentration* (mol. 1^{-1})	*Method of Preparation*	*T* (°C)	*Conductivity* S.m^{-1}
A	1	71.135 2 g of KCl weighed in vacuum per kilogram of solution	0	6.517 6
			18	9.783 8
			25	11.134 2
B	0.1	7.419 1 g of KCl weighed in vaccum per kilogram of solution	0	7.138×10^{-1}
			18	11.167×10^{-1}
			25	12.856×10^{-1}
C	0.01	0.745 3 g of KCl weighed in vaccum per kilogram of solution	0	7.736×10^{-2}
			18	12.205×10^{-2}
			25	14.088×10^{-2}
D	0.001	Dilute 100 ml of solution C to 11 at 20°C	25	14.693×10^{-3}

---

* Corrected for the conductivity of the water used to prepare the solutions.

These tabulated conductivity values are in international units.

Deionized water, with a negligible conductivity compared with the stated value, preferably lower than 2 $\mu s.cm^{-1}$ at 25°C, shall be used for the preparation of each solution.

For the preparation of the solutions, potassium chloride of analytical grade shall be used, dried for at least 2 h at 220°C - 240°C.

Calibration Solution	*Approximate Concentration* (mol. 1^{-1})	*Method of Preparation*	*T* (°C)	*Conductivity* S.m^{-1}
A	1	74.246 0 g of KCI weighed in air per litre of solution	0	6.517 6
			18	9.783 8
			25	11.134 2
B	0.1	7.436 5 g of KCI weighed in air per litre of solution	0	7.138×10^{-1}
			18	11.167×10^{-1}
			25	12.856×10^{-1}
C	0.01	0.744 0 g of KCI weighed in air per litre of solution	0	7.736×10^{-2}
			18	12.205×10^{-2}
			25	14.088×10^{-2}
D	0.001	Dilute 100 ml of solution C to 11 at 20°C	25	14.693×10^{-3}

ANNEX B

(*Clause* 6.2)

TEST SOLUTIONS

Tables of the Resistivity of Aqueous Sodium Chloride Solutions

(*See* Tables 1, 2 *and* 3)

The concentrations are given in weight/weight percentage.

The tables can be converted to conductivity tables by calculating the reciprocals of the given resistivity values.

For the preparation of the solutions, deionized water shall be used, and sodium chloride of analytical grade, dried for at least 2 h at 220°C-240°C.

The tabulated values are for a temperature of 18°C. Values for other temperatures can be calculated by the equation:

$$R_t = \frac{R_{18}}{[1 + b_t\,(t - 18)]}$$

where b_t is the temperature coefficient (Table 2 corrected by Table 3).

The use of the tables is illustrated in the following example:

Example:

What is the specific resistivity of a sodium chloride solution containing 0.024 percent NaCl at 63.4°C.

The resistivity at 18 °C = 2 342.6 cm, Table 1

The value of b_t at 63.4 °C = 0.025 52, Table 2

The concentration corrected for b_t = 0, Table 3

The resistivity

$$\text{at } 63.4\ °C = \frac{2\,342.6}{[1 + 0.0255\,2\,(63.4 - 18)]}$$

$$= 1\,085.2 \text{ cm or } 0.092\,1\ Sm^{-1}$$

For the moment, no reliable data are available for high conductivity test solutions. Work is in progress to solve this problem.

Table 1 Sodium Chloride Solution Resistivities at 18°C (Ω.cm)

(*Annex* B)

% NaCl	0	2	4	6	8	10
0.001 0	54 210	53 152	52 136	51 157	50 215	49 306
0.001 1	49 306	48 431	47 586	46 770	45 981	45 219
0.001 2	45 219	44 482	43 768	43 077	42 408	41 759
0.001 3	41 759	41 130	40 520	39 927	39 352	38 793
0.001 4	38 793	38 250	37 722	37 208	36 708	36 222
0.001 5	36 222	35 748	35 287	34 837	34 399	33 971
0.001 6	33 971	33 554	33 148	32 751	32 363	31 985
0.001 7	31 985	31 615	31 254	30 901	30 556	30 219
0.001 8	30 219	29 889	29 566	29 250	28 941	28 639
0.001 9	28 639	28 342	28 052	27 768	27 489	27 216
0.002 0	27 216	26 948	26 686	26 428	26 176	25 928
0.002 1	25 928	25 686	25 447	25 213	24 983	24 758
0.002 2	24 758	24 536	24 319	24 105	23 895	23 689
0.002 3	23 689	23 486	23 287	23 091	22 898	22 709
0.002 4	22 709	22 522	22 339	22 159	21 981	21 807
0.002 5	21 807	21 635	21 466	21299	21 136	20 974
0.002 6	20 974	20 815	20 659	20 505	20 353	20 203
0.002 7	20 203	20 056	19 910	19 767	19 626	19 487
0.002 8	19 487	19 350	19 215	19 081	18 950	18 820
0.002 9	18 820	18 692	18 566	18 442	18 319	18 198
0.003 0	18 198	18 078	17 960	17 844	17 729	17 615
0.003 1	17 615	17 503	17 393	17 283	17 176	17 069
0.003 2	17 069	16 964	16 860	16 757	16 656	16 556
0.003 3	16 556	16 457	16 359	16 263	16 167	16 073
0.003 4	16 073	15 980	15 888	15 797	15 707	15 618
0.003 5	15 618	15 530	15 443	15 357	15 272	15 187
0.003 6	15 187	15 104	15 022	14 941	14 860	14 780
0.003 7	14 780	14 702	14 624	14 547	14 470	14 395
0.003 8	14 395	14 320	14 246	14 173	14 101	14 029
0.003 9	14 029	13 958	13 888	13816	13 750	13 681
0.004 0	13 681	13 614	13 547	13 816	13 416	13 351
0.004 1	13 351	13 286	13 223	13 160	13 098	13 036
0.004 2	13 036	12 975	12 914	12 854	12 794	12 735
0.004 3	12 735	12 677	12 619	12 562	12 505	12 449
0.004 4	12 449	12 393	12 338	12 283	12 228	12 175

Table 1 *(continued)*

% NaCl	0	2	4	6	8	10
0.004 5	12 175	12 121	12 068	12 016	11 964	11 912
0.004 6	11 912	11 861	11 811	11 761	11 711	11 661
0.004 7	11 661	11 613	11 564	11 516	11 468	11 421
0.004 8	11 421	11 374	11 327	11 281	11 236	11 190
0.004 9	11 190	11 145	11 100	11 056	11 012	10 969
0.005 0	10 969	10 925	10 882	10 840	10 798	10 756
0.005 1	10 756	10 714	10 673	10 632	10 591	10 551
0.005 2	10 551	10 511	10 471	10 432	10 393	10 354
0.005 3	10 354	10 315	10 277	10 239	10 202	10 164
0.005 4	10 164	10 127	10 090	10 054	10 017	9 981
0.005 5	9 981	9 946	9 910	9 875	9 840	9 805
0.005 6	9 805	9 771	9 736	9 702	9 669	9 635
0.005 7	9 635	9 602	9 569	9 536	9 503	9471
0.005 8	9 471	9 438	9 407	9 375	9 343	9 312
0.005 9	9 312	9 281	9 250	9 219	9 189	9 158
0.006 0	9 158	9 128	9 099	9 069	9 039	9 010
0.006 1	9 010	8 981	8 952	8 923	8 895	8 866
0.006 2	8 866	8 838	8 810	8 782	8 755	8 727
0.006 3	8 727	8 700	8 673	8 646	8 619	8 593
0.006 4	8 593	8 566	8 540	8 514	8 488	8 462
0.006 5	8 462	8 436	8 411	8 385	8 360	8 335
0.006 6	8 335	8 310	8 286	8 261	8 237	8 212
0.006 7	8 212	8 188	8 164	8 140	8 117	8 093
0.006 8	8 093	8 070	8 046	8 023	8 000	7 977
0.006 9	7 977	7 954	7 932	7 909	7 887	7 865
0.007 0	7 865	7 843	7 821	7 799	7 777	7 755
0.007 1	7 755	7 734	7 712	7 691	7 670	7 649
0.007 2	7 649	7 628	7 607	7 587	7 566	7 546
0.007 3	7 546	7 525	7 505	7485	7 465	7 445
0.007 4	7 445	7 425	7 405	7 386	7 366	7 347
0.007 5	7 347	7 328	7 309	7 289	7 270	7 252
0.007 6	7 252	7 233	7 214	7 196	7 177	7 159
0.007 7	7 159	7 140	7 122	7 104	7 086	7 068
0.007 8	7 068	7 050	7 033	7 015	6 997	6 980
0.007 9	6 980	6 963	6 945	6 928	6 911	6 894
0.008 0	6 894	6 877	6 860	6 843	6 827	6 810
0.008 1	6 810	6 793	6 777	6 761	6 744	6 728

Table 1 (*continued*)

% NaCl	0	2	4	6	8	10
0.008 2	6 728	6 712	6 696	6 680	6 664	6 648
0.008 3	6 648	6 632	6 617	6 601	6 586	6 570
0.008 4	6 570	6 555	6 540	6 521	6 509	6 494
0.008 5	6 494	6 479	6 464	6 449	6 434	6 420
0.008 6	6 420	6 405	6 390	6 376	6 361	6 347
0.008 7	6 347	6 333	6 318	6 304	6 290	6 276
0.008 8	6 276	6 262	6 248	6 234	6 220	6 206
0.008 9	6 206	6 193	6 179	6 166	6 152	6 139
0.009 0	6 139	6 125	6 112	6 099	6 085	6 072
0.009 1	6 072	6 059	6 046	6 033	6 020	6 007
0.009 2	6 007	5 994	5 982	5 969	5 956	5 944
0.009 3	5 944	5 931	5 919	5 906	5 894	5 881
0.009 4	5 881	5 869	5 857	5 845	5 833	5 821
0.009 5	5 821	5 808	5 797	5 785	5 773	5 761
0.009 6	5 761	5 749	5 737	5 726	5 714	5 702
0.009 7	5 702	5 691	5 679	5 668	5 657	5 645
0.009 8	5 645	5 634	5 623	5 611	5 600	5 589
0.009 9	5 589	5 578	5 567	5 556	5 545	5 534
0.010	5 534.2	5 428.2	5 325.4	5 226.4	5 131.1	5 039.2
0.011	5 039.2	4 950.6	4 865.1	4 782.5	4 702.7	4 625.5
0.012	4 625.5	4 550.9	4 478.7	4 408.7	4 341.0	4 275.3
0.013	4 275.3	4 211.6	4 149.7	4 089.7	4 031.5	3 974.8
0.014	3 974.8	3 919.8	3 866.3	3 814.2	3 763.6	3 714.3
0.015	3 714.3	3 666.2	3 619.5	3 573.9	3 529.4	3 486.1
0.016	3 486.1	3 443.9	3 402.6	3 362.4	3 323.1	3 284.7
0.017	3 284.7	3 247.2	3 210.6	3 174.8	3 139.7	3 105.5
0.018	3 105.5	3 072.0	3 039.3	3 007.2	2 975.8	2 945.1
0.019	2 945.1	2 915.0	2 885.6	2 856.7	2 828.4	2 800.7
0.020	2 800.7	2 773.5	2 746.8	2 720.7	2 695.1	2 669.9
0.021	2669.9	2 645.2	2 621.0	2 597.2	2 573.9	2 551.0
0.022	2 551.0	2 528.5	2 506.3	2 484.6	2 463.3	2 442.3
0.023	2 442.3	2 421.7	2 401.4	2 381.5	2 361.9	2 342.6
0.024	2 342.6	2 323.7	2 305.1	2 286.7	2 268.7	2 250.9
0.025	2 250.9	2 233.4	2 216.2	2 199.3	2 182.6	2 166.2
0.026	2 166.2	2 150.0	2 134.1	2 118.4	2 102.9	2 087.7
0.027	2 087.7	2 072.7	2 057.9	2 043.3	2 029.0	2 014.8
0.028	2 014.8	2 000.8	1 987.1	1 973.5	1 960.1	1 946.9

Table 1 (*continued*)

% NaCl	0	2	4	6	8	10
0.029	1 946.9	1 933.8	1 921.0	1 908.3	1 895.8	1 883.5
0.030	1 883.5	1 871.3	1 859.2	1 847.4	1 835.7	1 824.1
0.031	1 824.1	1 812.7	1 801.4	1 790.3	1 779.3	1 768.4
0.032	1 768.4	1 757.7	1 747.1	1 736.7	1 726.3	1 716.1
0.033	1 716.1	1 706.0	1 696.0	1 686.2	1 676.5	1 666.8
0.034	1 666.8	1 657.3	1 647.9	1 638.6	1 629.5	1 620.4
0.035	1 620.4	1 611.4	1 602.5	1 593.7	1 585.0	1 576.5
0.036	1 576.5	1 568.0	1 559.6	1 551.3	1 543.0	1 534.9
0.037	1 534.9	1 526.9	1 518.9	1 511.0	1 503.2	1 495.5
0.038	1 495.5	1 487.9	1 480.3	1 472.9	1 465.5	1 458.2
0.039	1 458.2	1 450.9	1 443.7	1 436.6	1 429.6	1 422.6
0.040	1 422.6	1 415.7	1 408.9	1 402.1	1 395.5	1 388.8
0.041	1 388.8	1 382.3	1 375.8	1 369.3	1 362.9	1 356.6
0.042	1 356.6	1 350.4	1 344.2	1 338.0	1 331.9	1 325.9
0.043	1 325.9	1 319.9	1 314.0	1 308.1	1 302.3	1 296.6
0.044	1 296.6	1 290.9	1 285.2	1 279.6	1 274.0	1 268.5
0.045	1 268.5	1 263.1	1 257.6	1 252.3	1 247.0	1 241.7
0.046	1 241.7	1 236.5	1 231.3	1 226.1	1 221.0	1 216.0
0.047	1 216.0	1 211.0	1 206.0	1 201.1	1 196.2	1 191.3
0.048	1 191.3	1 186.5	1 181.8	1 177.0	1 172.4	1 167.7
0.049	1 167.7	1 163.1	1 158.5	1 154.0	1 149.5	1 145.0
0.050	1 145.0	1 140.6	1 136.2	1 131.8	1 127.5	1 123.2
0.051	1 123.2	1 118.9	1 114.7	1 110.5	1 106.3	1 102.2
0.052	1 102.2	1 098.1	1 094.0	1 090.0	1 086.0	1 082.0
0.053	1 082.0	1 078.0	1 074.1	1 070.2	1 066.4	1 062.5
0.054	1 062.5	1 058.7	1 054.9	1 051.2	1 047.5	1 043.8
0.055	1 043.8	1 040.1	1 036.4	1 032.8	1 029.2	1 025.7
0.056	1 025.7	1 022.1	1 018.6	1 015.1	1 011.6	1 008.2
0.057	1 008.2	1 004.8	1 001.4	998.0	994.6	991.3
0.058	991.3	988.0	984.7	981.5	978.2	975.0
0.059	975.0	971.8	968.6	965.5	962.4	959.2
0.060	959.2	956.2	953.1	950.0	947.0	944.0
0.061	944.0	941.0	938.0	935.1	932.1	929.2
0.062	929.2	926.3	923.4	920.6	917.7	914.9
0.063	914.9	912.1	909.3	906.5	903.8	901.1
0.064	901.1	898.3	895.6	892.9	890.3	887.6
0.065	887.6	885.0	882.4	879.7	877.2	874.6

Table 1 *(continued)*

% NaCl	0	2	4	6	8	10
0.066	874.6	872.0	869.5	866.9	864.4	861.9
0.067	861.9	859.4	857.0	854.5	852.1	849.6
0.068	849.6	847.3	844.8	842.4	840.1	837.7
0.069	837.7	835.4	833.0	830.7	828.4	826.1
0.070	826.1	823.8	821.6	819.3	817.1	814.9
0.071	814.9	812.6	810.4	808.2	806.1	803.9
0.072	803.9	801.7	799.6	797.5	795.3	793.2
0.073	793.2	791.1	789.0	787.0	784.9	782.9
0.074	782.9	780.8	778.8	776.8	774.8	772.8
0.075	772.8	770.8	768.8	766.8	764.9	762.9
0.076	762.9	761.0	759.0	757.1	755.2	753.3
0.077	753.3	751.4	749.6	747.7	745.8	744.0
0.078	744.0	742.1	740.3	738.5	736.7	734.9
0.079	734.9	733.1	731.3	729.5	727.7	726.0
0.080	726.0	724.2	722.5	720.8	719.0	717.3
0.081	717.3	715.6	713.9	712.2	710.5	708.9
0.082	708.9	707.2	705.5	703.9	702.2	700.6
0.083	700.6	699.0	697.4	695.7	694.1	692.5
0.084	692.5	690.9	689.4	687.8	686.2	684.7
0.085	684.7	683.1	681.6	680.0	678.5	677.0
0.086	677.0	675.5	673.9	672.4	670.9	669.4
0.087	669.4	668.0	666.5	665.0	663.6	662.1
0.088	662.1	660.6	659.2	657.8	656.3	654.9
0.089	654.9	653.5	652.1	650.7	649.3	647.9
0.090	647.9	646.5	645.1	643.7	642.4	641.0
0.091	641.0	639.6	638.3	637.0	635.6	634.3
0.092	634.3	632.9	631.6	630.3	629.0	627.7
0.093	627.7	626.4	625.1	623.8	622.5	621.2
0.094	621.2	620.0	618.7	617.4	616.2	614.9
3.5	20.581	20.473	20.367	20.262	20.159	20.056
3.6	20.056	19.954	19.854	19.755	19.656	19.559
3.7	19.559	19.463	19.368	19.274	19.181	19.088
3.8	19.088	18.997	18.907	18.817	18.729	18.641
3.9	18.641	18.555	18.469	18.384	18.300	18.217
4.0	18.217	18.134	18.053	17.972	17.892	17.813
4.1	17.813	17.734	17.656	17.579	17.503	17.428
4.2	17.428	17.353	17.279	17.205	17.133	17.060

Table 1 (*continued*)

% NaCl	0	2	4	6	8	10
4.3	17.060	16.989	16.918	16.848	16.779	16.710
4.4	16.710	16.642	16.574	16.507	16.441	16.375
4.5	16.375	16.309	16.245	16.181	16.117	16.054
4.6	16.054	15.992	15.930	15.868	15.807	15.747
4.7	15.747	15.687	15.628	15.569	15.511	15.453
4.8	15.453	15.395	15.338	15.282	15.226	15.170
4.9	15.170	15.115	15.061	15.006	14.953	14.899
5.0	14.899	14.846	14.794	14.742	14.690	14.639
5.1	14.639	14.588	14.537	14.487	14.438	14.388
5.2	14.388	14.339	14.291	14.242	14.195	14.147
5.3	14.147	14.100	14.053	14.007	13.961	13.915
5.4	13.915	13.869	13.824	13.780	13.735	13.691
5.5	13.691	13.647	13.604	13.561	13.518	13.475
5.6	13.475	13.433	13.391	13.349	13.308	13.267
5.7	13.267	13.226	13.186	13.145	13.105	13.066
5.8	13.066	13.026	12.987	12.948	12.910	12.871
5.9	12.871	12.833	12.796	12.758	12.721	12.684.
6.0	12.684	12.647	12.610	12.574	12.538	12.502
6.1	12.502	12.466	12.431	12.396	12.361	12.326
6.2	12.326	12.291	12.257	12.223	12.189	12.156
6.3	12.156	12.122	12.089	12.056	12.023	11.990
6.4	11.990	11.958	11.926	11.894	11.862	11.831
6.5	11.831	11.799	11.768	11.737	11.706	11.675
6.6	11.675	11.645	11.615	11.584	11.555	11.525
6.7	11.525	11.495	11.466	11.437	11.408	11.379
6.8	11.379	11.350	11.321	11.293	11.265	11.237
6.9	11.237	11.209	11.181	11.154	11.126	11.099
7.0	11.099	11.072	11.045	11.018	10.991	10.965
7.1	10.965	10.938	10.912	10.886	10.860	10.835
7.2	10.835	10.809	10.783	10.758	10.733	10.708
7.3	10.708	10.683	10.658	10.633	10.609	10.584
7.4	10.584	10.560	10.536	10.512	10.488	10.464
7.5	10.464	10.441	10.417	10.394	10.371	10.347
7.6	10.347	10.324	10.301	10.279	10.256	10.233
7.7	10.233	10.211	10.189	10.166	10.144	10.122
7.8	10.122	10.101	10.079	10.057	10.030	10.014
7.9	10.014	9.993	9.972	9.951	9.930	9.909

Table 1 (*continued*)

% NaCl	0	2	4	6	8	10
8.0	9.909	9.888	9.867	9.847	9.826	9.806
8.1	9.806	9.785	9.765	9.745	9.725	9.705
8.2	9.705	9.685	9.666	9.646	9.627	9.607
8.3	9.607	9.588	9.569	9.549	9.530	9.511
8.4	9.511	9.493	9.474	9.455	9.436	9.418
8.5	9.418	9.399	9.381	9.363	9.345	9.237
8.6	9.327	9.308	9.291	9.273	9.255	9.237
8.7	9.237	9.220	9.202	9.185	9.167	9.150
8.8	9.150	9.133	9.116	9.099	9.082	9.065
8.9	9.065	9.048	9.031	9.014	8.998	8.981
9.0	8.981	8.965	8.948	8.932	8.916	8.900
9.1	8.900	8.883	8.867	8.851	8.836	8.820
9.2	8.820	8.804	8.788	8.773	8.757	8.741
9.3	8.741	8.726	8.711	8.695	8.680	8.665
9.4	8.665	8.650	8.635	8.620	8.605	8.590
0.65	97.87	97.59	97.31	97.03	96.75	96.47
0.66	96.47	96.20	95.92	95.65	95.38	95.11
0.67	95.11	94.84	94.58	94.32	94.05	93.79
0.68	93.79	93.53	93.28	93.02	92.76	92.51
0.69	92.51	92.26	92.01	91.76	91.51	91.26
0.70	91.26	91.02	90.78	90.53	90.29	90.05
0.71	90.05	89.82	89.58	89.34	89.11	88.88
0.72	88.88	88.64	88.41	88.18	87.96	87.73
0.73	87.73	87.50	87.28	87.06	86.84	86.61
0.74	86.61	86.40	86.18	85.96	85.74	85.53
0.75	85.53	85.32	85.10	84.89	84.68	84.47
0.76	84.47	84.26	84.06	83.85	83.64	83.44
0.77	83.44	83.24	83.04	82.83	82.63	82.44
0.78	82.44	82.24	82.04	81.85	81.65	81.46
0.79	81.46	81.26	81.07	80.88	80.69	80.50
0.80	80.50	80.31	80.13	79.94	79.75	79.57
0.81	79.57	79.39	79.20	79.02	78.84	78.66
0.82	78.66	78.48	78.30	78.13	77.95	77.77
0.83	77.77	77.60	77.42	77.25	77.08	76.91
0.84	76.91	76.74	76.57	76.40	76.23	76.06
0.85	76.06	75.89	75.73	75.56	75.40	75.23
0.86	75.23	75.07	74.91	74.75	74.59	74.43
0.87	74.43	74.27	74.11	73.95	73.79	73.64

Table 1 (*continued*)

% NaCl	0	2	4	6	8	10
0.88	73.64	73.48	73.33	73.17	73.02	72.86
0.89	72.86	72.71	72.56	72.41	72.26	72.11
0.90	72.11	71.96	71.81	71.66	71.52	71.37
0.91	71.37	71.23	71.08	70.94	70.79	70.65
0.92	70.65	70.51	70.36	70.22	70.08	69.94
0.93	69.94	69.80	69.66	69.53	69.39	69.25
0.94	69.25	69.11	68.98	68.84	68.71	68.57
0.95	68.57	68.44	68.31	68.17	68.04	67.91
0.96	67.91	67.78	67.65	67.52	67.39	67.26
0.97	67.26	67.13	67.00	66.88	66.75	66.62
0.98	66.62	66.50	66.37	66.25	66.12	66.00
0.99	66.00	65.88	65.75	65.63	65.51	65.39
1.0	65.387	64.162	63.056	61.988	60.955	59.956
1.1	59.956	58.989	58.053	57.146	56.267	55.414
1.2	55.414	54.587	53.785	53.005	52.249	51.513
1.3	51.513	50.798	50.103	49.427	48.769	48.128
1.4	48.128	47.504	46.896	46.304	45.727	45.164
1.5	45.164	44.615	44.080	43.557	43.047	42.548
1.6	42.548	42.062	41.586	41.122	40.667	40.223
1.7	40.223	39.789	39.364	38.949	38.542	38.144
1.8	38.144	37.754	37.373	36.999	36.633	36.274
1.9	36.274	35.922	35.577	35.239	34.908	34.583
2.0	34.583	34.264	33.951	33.644	33.342	33.046
2.1	33.046	32.756	32.471	32.191	31.915	31.645
2.2	31.645	31.379	31.118	30.862	30.610	30.362
2.3	30.362	30.118	29.878	29.642	29.410	29.182
2.4	29.182	28.958	28.737	28.519	28.305	28.095
2.5	28.095	27.887	27.683	27.482	27.284	27.089
2.6	27.089	26.896	26.707	26.520	26.337	26.155
2.7	26.155	25.977	25.801	25.627	25.456	25.288
2.8	25.288	25.121	24.957	24.795	24.636	24.478
2.9	24.478	24.323	24.170	24.019	23.869	23.722
3.0	23.722	23.577	23.433	23.292	23.152	23.014
3.1	23.014	22.878	22.743	22.610	22.479	22.349
3.2	22.349	22.221	22.095	21.970	21.846	21.725
3.3	21.725	21.604	21.485	21.367	21.251	21.136
3.4	21.136	21.022	20.910	20.799	20.689	20.581
3.5	20.581	20.473	20.367	20.262	20.159	20.056

Table 1 (*continued*)

% NaCl	0	2	4	6	8	10
3.6	20.056	19.954	19.854	19.755	19.656	19.559
3.7	19.559	19.463	19.368	19.274	19.181	19.088
3.8	19.088	18.997	18.907	18.817	18.729	18.641
3.9	18.641	18.555	18.469	18.384	18.300	18.217
4.0	18.217	18.134	18.053	17.972	17.892	17.813
4.1	17.813	17.734	17.656	17.579	17.503	17.428
4.2	17.428	17.353	17.279	17.205	17.133	17.060
4.3	17.060	16.989	16.918	16.848	16.779	16.710
4.4	16.710	16.642	16.574	16.507	16.441	16.375
4.5	16.375	16.309	16.245	16.181	16.117	16.054
4.6	16.054	15.992	15.930	15.868	15.807	15.747
4.7	15.747	15.687	15.628	15.569	15.511	15.453
4.8	15.453	15.395	15.338	15.282	15.226	15.170
4.9	15.170	15.115	15.061	15.006	14.953	14.899
5.0	14.899	14.846	14.794	14.742	14.690	14.639
5.1	14.639	14.588	14.537	14.487	14.438	14.388
5.2	14.388	14.339	14.291	14.242	14.195	14.147
5.3	14.147	14.100	14.053	14.007	13.961	13.915
5.4	13.915	13.869	13.824	13.780	13.735	13.691
5.5	13.691	13.647	13.604	13.561	13.518	13.475
5.6	13.475	13.433	13.391	13.349	13.308	13.267
5.7	13.267	13.226	13.186	13.145	13.105	13.066
5.8	13.066	13.026	12.987	12.948	12.910	12.871
5.9	12.871	12.833	12.796	12.758	12.721	12.684
6.0	12.684	12.647	12.610	12.574	12.538	12.502
6.1	12.502	12.466	12.431	12.396	12.361	12.326
6.2	12.326	12.291	12.257	12.223	12.189	12.156
6.3	12.156	12.122	12.089	12.056	12.023	11.990
6.4	11.990	11.958	11.926	11.894	11.862	11.831
6.5	11.831	11.799	11.768	11.737	11.706	11.675
6.6	11.675	11.645	11.615	11.584	11.555	11.525
6.7	11.525	11.495	11.466	11.437	11.408	11.379
6.8	11.379	11.350	11.321	11.293	11.265	11.237
6.9	11.237	11.209	11.181	11.154	11.126	11.099
7.0	11.099	11.072	11.045	11.018	10.991	10.965
7.1	10.965	10.938	10.912	10.886	10.860	10.835
7.2	10.835	10.809	10.783	10.758	10.733	10.708

Table 1 (*continued*)

% NaCl	0	2	4	6	8	10
7.3	10.708	10.683	10.658	10.633	10.609	10.584
7.4	10.584	10.560	10.536	10.512	10.488	10.464
7.5	10.464	10.441	10.417	10.394	10.371	10.347
7.6	10.347	10.324	10.301	10.279	10.256	10.233
7.7	10.233	10.211	10.189	10.166	10.144	10.122
7.8	10.122	10.101	10.079	10.057	10.030	10.014
7.9	10.014	9.993	9.972	9.951	9.930	9.909
8.0	9.909	9.888	9.867	9.847	9.826	9.806
8.1	9.806	9.785	9.765	9.745	9.725	9.705
8.2	9.705	9.685	9.666	9.646	9.627	9.607
8.3	9.607	9.588	9.569	9.549	9.530	9.511
8.4	9.511	9.493	9.474	9.455	9.436	9.418
8.5	9.418	9.399	9.381	9.363	9.345	9.327
8.6	9.327	9.308	9.291	9.273	9.255	9.237
8.7	9.237	9.220	9.202	9.185	9.167	9.150
8.8	9.150	9.133	9.116	9.099	9.082	9.065
8.9	9.065	9.048	9.031	9.014	8.998	8.981
9.0	8.981	8.965	8.948	8.932	8.916	8.900
9.1	8.900	8.883	8.867	8.851	8.836	8.820
9.2	8.820	8.804	8.788	8.773	8.757	8.741
9.3	8.741	8.726	8.711	8.695	8.680	8.665
9.4	8.665	8.650	8.635	8.620	8.605	8.590
9.5	8.590	8.575	8.560	8.546	8.531	8.517
9.6	8.517	8.502	8.488	8.473	8.459	8.445
9.7	8.445	8.430	8.416	8.402	8.388	8.374
9.8	8.374	8.360	8.346	8.333	8.319	8.305
9.9	8.305	8.292	8.278	8.264	8.251	8.237
10	8.237	8.123	8.010	7.898	7.787	7.674
11	7.674	7.572	7.473	7.376	7.281	7.189
12	7.189	7.099	7.011	6.926	6.843	6.762
13	6.762	6.684	6.608	6.535	6.463	6.394
14	6.394	6.327	6.262	6.199	6.138	6.079
15	6.079	6.022	5.966	5.913	5.861	5.811
16	5.811	5.763	5.716	5.670	5.627	5.584
17	5.584	5.543	5.504	5.465	5.428	5.393
18	5.393	5.358	5.325	5.292	5.261	5.231
19	5.231	5.202	5.174	5.147	5.120	5.095

Table 1 (*concluded*)

% NaCl	0	2	4	6	8	10
20	5.095	5.071	5.047	5.024	5.002	4.981
21	4.981	4.961	4.941	4.922	4.903	4.886
22	4.886	4.868	4.852	4.836	4.821	4.806
23	4.806	4.792	4.778	4.765	4.752	4.740
24	4.740	4.728	4.716	4.705	4.695	4.685
25	4.685	4.675	4.666	4.657	4.648	4.640
26	4.640	4.632	4.624			

Table 2 Temperature Coefficients for Low-Concentration Sodium Chloride Solutions

(*Annex* B)

Temperature (°C)	0	2	4	6	8	10
0	0.0211 8	0.0213 4	0.0215 0	0.0216 6	0.0218 2	0.0219 8
10	0.0219 8	0.0221 3	0.0222 9	0.0224 5	0.0226 1	0.0227 7
20	0.0227 7	0.0229 2	0.0230 8	0.0232 3	0.0233 8	0.0235 3
30	0.0235 3	0.0236 7	0.0238 2	0.0239 6	0.0240 9	0.0242 3
40	0.0242 3	0.0243 6	0.0244 9	0.0246 1	0.0247 4	0.0248 6
50	0.0248 6	0.0249 7	0.0250 8	0.0251 9	0.0252 9	0.0253 9
60	0.0253 9	0.0254 9	0.0255 8	0.0256 7	0.0257 6	0.0258 4
70	0.0258 4	0.0259 1	0.0259 9	0.0260 6	0.0261 2	0.0261 8
80	0.0261 8	0.0262 4	0.0262 9	0.0263 4	0.0263 9	0.0264 3
90	0.0264 3	0.0264 7	0.0265 1	0.0265 4	0.0265 7	0.0266 0
100	0.0266 0	0.0266 2	0.0266 5	0.0266 6	0.0266 8	0.0266 9
110	0.0266 9	0.0267 1	0.0267 2	0.0267 3	0.0267 3	0.0267 4
120	0.0267 4	0.0267 4	0.0267 5	0.0267 5	0.0267 5	0.0267 6
130	0.0267 6	0.0267 6	0.0267 6	0.0267 7	0.0267 7	0.0267 8
140	0.0267 8	0.0267 9	0.0268 0	0.0268 1	0.0268 3	0.0268 4

Table 3 Tentative Corrections to Sodium Chloride Solution Temperature Coefficients

(*Annex* B)

Temperature (°C)	% NaCl			
	0.1	0.5	1.0	5.0
0	-0.000 1	-0.000 4	-0.000 9	-0.001 1
50	-0.000 1	-0.000 7	-0.000 7	-0.000 4
100	-0.000 2	-0.001 2	-0.000 4	+0.000 4

ANNEX C

(*Clause* 6.3.6)

Alternative Procedures for Measuring Delay Time (T_{10}) Rise (Fall) Time (T_r,T_f) and 90 Percent Time (T_{90})

Procedure A

A recorder is connected to the output terminals of the analyzer. The sensor unit is placed in a flow-through cell (as similar as possible to that cell used in the application) and equipped with a two-way stopcock to supply alternately test solutions with low and high electrolytic conductivity values. A test solution representing the minimum rated value is supplied until a constant reading on the maximum rated value and a mark is made on the recorder chart. The maximum value test solution is supplied until a constant reading is obtained. Then the stopcock is switched back to the minimum value solution and a second mark is made on the recorder chart. Again, the minimum value solution is supplied until a constant reading is obtained.

The flow rate of the solutions shall be adjusted to the maximum specified by the manufacturer as the normal flow rate for the equipment. The temperature of solutions and sensor unit shall be constant within ±0·5°C and shall be reported with other results.

The values for delay time (T_{10}) and 90 percent time(T_{90}), for both increasing and decreasing step changes, rise time (T_r) and fall time (T_f), are determined through knowledge of the chart speed. The larger of the two delay times, the larger of rise or fall time and the larger of the two 90 percent times are reported.

Procedure B

Similar to A above except that the sensor unit is immersed alternately in two different beakers, one containing a stirred test solution representing the minimum rated electrolytic conductivity value and the other containing a stirred test solution representing the maximum rated electrolytic conductivity value. When transferring the sensor unit from one beaker to the other, the sensor unit is shaken off but not wiped and not rinsed. The sensor unit is left in the beakers until constant readings are obtained.

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